

NOTES ON MICROSPORE-TYPES IN TASMANIAN PERMIAN COALS.

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(One Text-figure.)

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INTRODUCTION.

A preliminary survey of microspore-types in Tasmanian Permian coals was undertaken with the object of recording the principal types present, obtaining data regarding assemblages in different occurrences, comparing general assemblages in Tasmanian and New South Wales Permian coal measures, and accumulating information which may eventually be of use in palaeobotany and its application to stratigraphy.

Coal samples used in the investigation (Table I) were supplied by the Tasmanian Department of Mines. It was not possible to obtain samples from all occurrences of Permian coal in Tasmania, but the material was sufficient to provide data for preliminary purposes.

TABLE 1.
Permian Coal Samples Examined.

Syd. Uni. Coal Serial Number.	Locality.	Coalfield or District.
CS 157	Illamatha Mine.	Mersey Coalfield.
CS 158	Aberdeen Mine.	Mersey Coalfield.
CS 159	Tarleton Mine.	Mersey Coalfield.
CS 190	Mole Creek.	Mersey Coalfield.
CS 191	Mount Pelion.	Western District.
CS 192	Cradoc.	South-eastern District.
CS 213	Preolena.	Western District.
CS 311	Latrobe.	Northern District.
CS 324	Wynyard.	North-western District.

Spore concentrates were prepared from the coal samples and mounted for microscopical examination by a method already described (Dulhunty, 1945). The Preolena material was cannel coal and no microspores were found in it. The Latrobe sample was a type of oil shale, known as Tasmanite, consisting almost entirely of macrospores. The concentrate prepared from this material contained an abundance of well-preserved macrospores, but only a limited number of microspores could be found. These were imperfectly preserved and insufficient in number to provide an assemblage for comparison with other occurrences, but the types recognized are recorded in Table 4. All the other coal samples contained large numbers of well-preserved microspores suitable for the study of types and assemblages.

A thorough search was made in each concentrate for types known to occur in New South Wales Permian coals; new types were studied; and spore counts were made to determine the relative abundance of all types present. Each spore type was then referred to one of five general orders of abundance depending on the percentage which it represented of the total number of spores counted in the concentrate. The five orders of abundance and the percentages to which they correspond are set out in

Table 2. This procedure was adopted as it was considered that the limited number of samples available for examination did not justify the consideration of actual percentages in discussing the significance of results.

TABLE 2.
General Orders of Abundance.

Abundance Number.	General Order of Abundance.	Corresponding Percentages.
1	Rare.	0.5% and less
2	Infrequent.	0.6% to 1.9%
3	Common.	2.0% to 4.9%
4	Abundant.	5.0% to 7.9%
5	Very abundant.	8.0% and over

The system used for type-numbering of spores in this work was that adopted in describing New South Wales Permian microspores (Dulhunty, 1945). For details of the system, and descriptions and illustrations of spore-types, reference should be made to the foregoing publication. For the convenience of readers, however, an abridged key to the spore-types is given in Table 3. It is hoped that type-numbering systems may eventually be abandoned in preference for the use of systematic binomial nomenclature. However, type numbers were used for the purpose of presenting the present results as a systematic classification of Australian microspores is not yet available.

TABLE 3.
Abridged Key to Spore-Types.

Examples of type-numbering: P2A, P29B, P34C, P40D.

Letter P preceding type-number indicates Permian type.

Letter A, B, C or D following type-number indicates variations in size or minor details belonging to the same general type.

Type-numbers (2, 29, 34, 40 in above examples) refer to body-shape, tetrad scar and ornamentation, as follows:

1. Angular tetrahedral; trilete; psilate.	18. Ellipsoidal; monolete; echinate.
2. Sub-angular tetrahedral; trilete; psilate.	19. Spheroidal; trilete; echinate.
3. Ellipsoidal; monolete; psilate.	20. Spheroidal; monolete; echinate.
4. Spheroidal; trilete; psilate.	21. Angular tetrahedral; trilete; striate.
5. Spheroidal; monolete; psilate.	23. Ellipsoidal; monolete; striate.
6. Angular tetrahedral; trilete; granulate.	26. Angular tetrahedral; trilete; verrucate.
7. Sub-angular tetrahedral; trilete; granulate.	28. Ellipsoidal; monolete; verrucate.
8. Ellipsoidal; monolete; granulate.	29. Spheroidal; trilete; verrucate.
9. Spheroidal; trilete; granulate.	30. Spheroidal; monolete; verrucate.
10. Spheroidal; monolete; granulate.	32. Sub-angular tetrahedral; trilete; monowinged.
13. Ellipsoidal; monolete; reticulate.	33. Ellipsoidal; monolete; monowinged.
14. Spheroidal; trilete; reticulate.	34. Spheroidal; trilete; monowinged.
15. Spheroidal; monolete; reticulate.	35. Spheroidal; monolete; monowinged.
16. Angular tetrahedral; trilete; echinate.	38. Ellipsoidal; monolete; biwinged.
17. Sub-angular tetrahedral; trilete; echinate.	40. Spheroidal; monolete; biwinged.

Results of the examination of the microspore concentrates are summarized in Table 4. In the case of each coal sample types present are shown by relative abundance numbers and those not found are indicated by dashes. Similar data representing average results for the Newcastle, Tomago, and Greta measures in New South Wales are included for comparison. The table shows distribution of microspores with respect to presence and absence of individual types, as well as variations in relative abundance and assemblages, in coals from the different Permian areas in Tasmania. In the case of the Latrobe material only a small number of different types was found and recorded owing to the rarity of microspores in the material.

Permian coal-measure stratigraphy in Tasmania was described by Johnston (1888); Loftus Hills, Ried, Nye, and Keid (1922); and later by Voisey (1938). Voisey's publication deals with results of previous workers; gives a full list of references; and reviews correlation of Permian stratigraphy in Tasmania and New South Wales. In Voisey's opinion there is difficulty in correlating the scattered occurrences of Permian strata within Tasmania, and there is considerable uncertainty regarding specific correlations (made by earlier workers) of various occurrences in Tasmania with the different stages and measures in New South Wales. He concludes, however, that Upper Palaeozoic rocks in Tasmania belong to the same system as those in type sections in the Hunter River district of New South Wales and that the two can be broadly correlated in a general way. In 1945 Dr. S. W. Carey kindly supplied notes and correlations of Tasmanian and New South Wales Permian strata.

Based on conclusions and observation of the foregoing workers, tentative stratigraphical positions of coals used in this investigation are as follows:

Upper Coal Measures: Mount Pelion; Cradoc; Preolena.

Lower Coal Measures: Mersey Coalfield, including Illamatha, Aberdeen, and Tarleton samples; Mole Creek; Latrobe; Wynyard.

Marine beds occur at the base of the sequence and also between the Lower and Upper Coal Measures which are generally believed to be equivalent to the Greta and Upper Coal Measures, respectively, in New South Wales.

MICROSPORES IN TASMANIAN PERMIAN COALS.

The majority of types occurring in both Tasmanian and New South Wales coals are almost identical and would appear to have come from similar plants. Some exhibit slight differences which are insufficient to justify the adoption of new type numbers. These may have been produced by plants representing variations of New South Wales Permian species, but the spores have been grouped under similar type numbers, as they possess the same essential features. Examples of such differences in spores of the same general type are as follows, characteristics of the Tasmanian spores being quoted. P1B, P3B, and P4B are somewhat smaller. P3A and P3C show less variation in size. P5A and P5C are more variable in size. P10B seldom exhibits a well-defined monolete opening. P14A is more variable in size and rarely shows the triangular opening and short trilete sutures at the centre. P15A is smaller and the reticulum is less distinct. The echinate spores, P16A to P20A, are smaller and possess shorter spines. P26A is frequently less angular in outline. P28A is more variable in size but tends to be larger. P40B exhibits slightly smaller wings. P40D is more variable in shape and the wings are set farther apart. P41A appears to vary from psilate to granulate and some examples were observed in which the exine was verrucate and even slightly echinate.

Several spore-types, present in Tasmanian Permian coals, have not yet been recognized in New South Wales and were not found in Queensland Permian coals recently examined by de Jersey (1946). Three of these, illustrated in Text-fig. 1, were found in sufficient numbers to establish types with definite characteristics. They are as follows:

Type P5D (No. 1, Text-fig. 1).

Spheroidal; distinctly flattened; circular or slightly oval outline in axial view. Exine thick-walled, giving a well-defined marginal rim. A small inner body of variable size and oval outline is situated within the spore near its centre or slightly to one side. A longitudinal feature resembling a monolete suture frequently appears on the inner body. No evidence of trilete sutures has been observed and the spore is presumed to be monolete. Usually psilate but faint granulation appears in some examples. Size is variable, diameter varying from one-third to two-thirds of the over-all diameter.

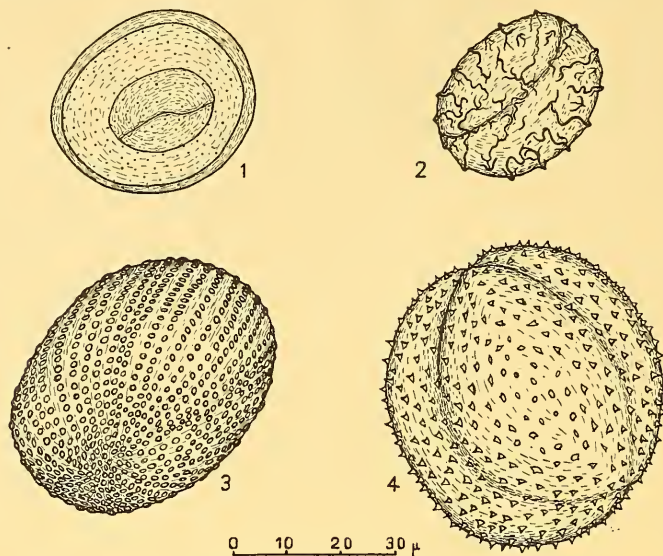
TABLE 4.
Distribution and Abundance of Microspores in Tasmanian Permian Coals.

Spore Types.	Tasmanian Coals.								N.S.W. Coal Measures.		
	Illamatha CS 157.	Aberdeen CS 158.	Tarleton CS 159.	Mole Creek CS 190.	Mount Pelion CS 191.	Cradoc CS 192.	Wynyard CS 324.	Latrobe CS 311.	Newcastle.	Tomago.	Greta.
P1A	2	1	1	2	1	2	1		4	4	3
P1B	2	1	1	1	1	2	2		4	5	5
P2A	1	—	—	1	1	—	—		3	2	2
P3A	3	4	4	3	2	2	5	1	5	5	5
P3B	1	1	1	1	—	—	1		2	2	—
P3C	4	5	5	3	3	3	4	1	5	5	5
P4A	1	—	—	—	—	—	1		1	2	1
P4B	1	1	—	1	—	—	1		2	2	2
P4C	2	1	1	1	1	1	—		2	2	2
P5A	3	3	2	—	—	3	3		4	3	3
P5B	2	2	2	2	2	2	—	1	3	3	3
P5C	5	4	4	3	3	5	3		5	4	5
P5D	2	3	2	2	3	2	2		—	—	—
P6A	1	1	1	—	1	2	1		2	2	3
P7A	1	1	—	1	1	—	—		2	3	2
P8A	2	2	2	1	2	2	2		4	4	3
P9A	1	—	1	—	—	1	—		1	2	—
P9B	2	—	1	—	1	2	1		2	1	2
P10A	3	3	2	—	1	1	—		3	3	3
P10B	2	3	1	2	3	2	3		4	4	3
P13A	1	—	1	1	—	—	1		2	2	—
P13B	3	3	3	2	1	2	1		—	—	—
P14A	2	2	3	1	1	2	2		3	3	3
P15A	1	1	—	—	—	—	—		—	—	2
P16A	—	—	—	2	3	2	—		2	3	1
P17A	—	—	—	1	1	2	—		2	3	1
P18A	—	—	—	2	—	—	—		2	2	1
P19A	—	—	—	1	2	—	—		1	2	1
P20A	—	—	—	1	—	2	—		1	2	1
P21A	—	—	—	—	—	—	—		1	—	—
P23A	1	1	1	1	1	1	1		1	1	2
P23B	1	1	—	1	1	—	—		1	1	1
P26A	2	2	2	—	—	2	1		1	2	3
P28A	2	1	2	—	—	—	—		1	—	2
P28B	1	—	—	—	—	—	1		—	—	—
P29A	—	1	1	—	—	—	—		1	—	2
P29B	—	—	—	—	—	—	—		2	1	4
P30A	—	—	1	—	—	—	—		—	1	1
P32A	—	—	—	—	—	—	—		—	—	2
P33A	1	—	1	—	—	—	—		1	—	—
P33B	1	—	—	—	—	—	—		1	2	—
P34A	—	—	—	—	—	—	—		1	—	—
P34B	1	—	—	—	—	—	1		2	2	2
P34C	—	—	—	—	—	—	—		1	2	1
P35A	—	—	1	—	—	—	—		1	2	1
P38A	—	—	—	2	2	—	—		2	2	1
P40A	—	—	—	—	1	1	—		2	2	—
P40B	—	—	—	—	1	1	—		2	1	—
P40C	2	—	—	2	3	3	2	1	3	3	2
P40D	1	1	—	1	2	—	—	1	2	3	1
P41A	3	3	3	4	3	1	3	1	2	2	3

Type P13B (No. 2, Text-fig. 1).

Ellipsoidal with oval to sub-oval outline. Monolete; frequently exhibiting well-defined suture or opening running the full length of the body. Length 40 to 60; width 30 to 40. Exine reticulate with a widely spaced system of anastomosing ridges

1 to 2 in width and 3 to 5 apart. Ridges appear at the margins of the spore producing irregularities in its outline.



Text-figure 1.—Permian microspore types present in Tasmanian coals, but not recognized in New South Wales Permian Measures.

Type P28B (No. 3, Text-fig. 1).

Ellipsoidal with oval to sub-oval outline. Monolete; at times showing a wide longitudinal opening. Length 55 to 65; width 40 to 50. Exine verrucate with large closely packed warts, 1 to 2 in width, arranged in a regular system of longitudinal rows.

Distribution and variation in abundance of the foregoing types are indicated in Table 4. P5D is widely distributed in Tasmanian coals, its abundance number varying from 2 to 3. P13B is also widely distributed, varying in abundance from 1 at Mount Pelion to 3 in the Mersey Coalfield. P28B was found in coal from the Illamatha Mine, where its abundance was only 1.

In addition to the three types described above, a single example of an unusual echinate spore (No. 4, Text-fig. 1) was found in Illamatha coal. A new type number was not given to this spore, as one individual was not considered sufficient to establish the occurrence of the type. It was spheroidal with approximately circular outline, and exhibited dehiscence along trilete sutures extending more than half-way round the body, which was 60 in diameter. The exine was echinate with very small spines, 0.75 to 1.0 in length, somewhat irregularly spaced at 1 to 2 apart. This spore is distinct from any other spined spores so far observed in Permian coals, and it was the only spined type found in samples from the Mersey Coalfield.

COMPARISON OF GENERAL ASSEMBLAGES IN TASMANIA AND NEW SOUTH WALES.

Of the 48 spore-types described from New South Wales Permian measures, 43 were found in Tasmanian coals. The types not recognized were P21A, P29B, P32A, P34A, and P34C. P21A is the unusual tetrahedral trilete type of special interest owing to the presence of three dome-shaped protuberances, somewhat resembling pollen-tube pores, situated at the centres of the three distal interfaces. It is rare in New South Wales coals, occurring only in the Newcastle Measures with sporadic lateral distribution. P29B is a large spheroidal verrucate trilete spore. It is widely distributed throughout all three subdivisions of New South Wales Permian and attains maximum abundance in the Greta Measures. P32A is a small tetrahedral trilete spore with a flange-like wing

situated in one place and attached to the distal interfaces which appear as the triangular outline of the body in proximal view. It is one of the two types (P32A and P15A) found only in the Greta Measures in New South Wales. Types P34A and P34C are monowinged spores with spheroidal trilete bodies. P34A occurs only in the Newcastle Measures, but P34C is found in all New South Wales Permian coal measures.

Some important differences were found in the Tasmanian and New South Wales microspore assemblages with respect to groups of closely related types. The monowinged spores (P33B, P34A, P34B, and P34C) which are relatively common in all New South Wales coal measures are almost completely absent from Tasmanian coals. Only three examples (one of P33B and two of P34B) of monowinged spores were found in all the Tasmanian material examined. These were in coal from Mersey and Wynyard areas, as indicated in Table 4. Three individuals are not sufficient to establish the presence of monowinged spores in the Tasmanian assemblage, as they may have been transported by wind from the mainland. This apparent absence of monowinged spores represents one of the principal differences in the two assemblages and it suggests that certain plants bearing monowinged spores may have been absent in Tasmania, although they flourished in New South Wales, during Permian time. Monowinged spores, similar to the New South Wales types, occur in Permian tillite at Bacchus Marsh in Victoria; in Lower Gondwana shales in India (Virkki, 1939); they have been observed by the writer in Permian coal from Collie in Western Australia; but they were not found in Queensland Permian coals examined by de Jersey (1946).

The echinate spores (P16A to P20A), absent from many of the Tasmanian coals, are less abundant than in the New South Wales Permian, where they occur persistently in coals from all measures. The biwinged spores, particularly P40A and P40B, are also far less common in Tasmania than in New South Wales. Psilate tetrahedral trilete spores (P1A, P1B, P2A) are represented in all Tasmanian coals but occur as minor constituents, whereas in New South Wales they are among the most abundant types. Ellipsoidal monolete types (P3A and P3C), and the small spheroidal monolete spore P5C, occur persistently and abundantly in both Tasmanian and New South Wales Permian measures.

The above results do not appear to bear any special stratigraphical significance. Of the types not found in Tasmanian coals, some are confined to the Upper Coal Measures and some to the Greta Measures in New South Wales. It would seem, however, that the results are significant in relation to the distribution of Permian plants in Australia. This subject, which is beyond the scope of the present work, requires further knowledge about relations between Permian spores and plants, but the general absence in Tasmania of certain spores relatively abundant in New South Wales, and *vice versa*, suggests that important results regarding distribution of Permian floras may be obtained from the study of microspores when the plants to which they belong are known.

VARIATIONS IN TASMANIAN SPORE ASSEMBLAGES.

Spore assemblages vary considerably in coals from different Permian localities in Tasmania, as illustrated in Table 4. The spined spores (P16A to P20A) appear to be completely absent from Illamatha, Aberdeen, and Tarleton coals in the Mersey Coalfield and also the Wynyard sample, although they are present in the other coals, including Mole Creek. Types P40A and P40B were found only in Mount Pelion and Cradoc materials, being absent from all the Mersey coals and Wynyard sample. The only examples of spheroidal monowinged spores, whether transported or indigenous, were found in Illamatha and Wynyard samples, and these were also the only two coals in which P38B and P4A were found. Mole Creek and Mount Pelion were the only coals in which P38A was present and from which P5A was absent.

These results indicate a general similarity in spore assemblages in coals from Illamatha, Aberdeen, Tarleton, and Wynyard, supporting the conclusions of previous workers that the Mersey and Wynyard coal measures are stratigraphically equivalent. Assemblages in Mount Pelion and Cradoc coals are similar, but differ somewhat from

those of the Mersey and Wynyard materials. This also supports existing views that Mount Pelion and Cradoc measures are equivalent but occur on a different horizon to the Mersey and Wynyard coals. The Mole Creek sample, however, contains an assemblage similar to that of Mount Pelion and Cradoc coal, and distinctly different from assemblages in samples from the Mersey field. This suggests that Mole Creek coal may be stratigraphically equivalent to that at Mount Pelion and Cradoc rather than seams mined at Illamatha, Aberdeen, and Tarleton collieries, as previously suggested.

The foregoing results suggest that it may be possible to use the absence of spined spores in correlating Tasmanian Permian areas equivalent to the Mersey and Wynyard coals, which are regarded as lower Permian in age.

Insufficient spore-types were recognized in the Latrobe material to indicate an assemblage, and the types identified bear no special stratigraphical significance, as they were found in practically all the Tasmanian coals examined.

APPLICATION OF RESULTS TO CORRELATION WITH NEW SOUTH WALES PERMIAN.

Attempts to apply preliminary results, recorded in this paper, to correlation of various Tasmanian occurrences with subdivisions of New South Wales Permian are not promising. The two assemblage groups, into which Tasmanian coals fall, cannot be matched with any assemblages in New South Wales coal measures. Certain spore-types appear to have restricted stratigraphical ranges in New South Wales (Dulhunty, 1946). Some of these occur in Tasmanian coals, but results based on their presence, or absence, are conflicting. P15A (confined to New South Wales Greta coal) is present in two of the Mersey coals and absent from Mole Creek, Mount Pelion, and Cradoc samples. Also, P40A and P40B (confined to Upper Coal Measures in New South Wales) were found only in Mount Pelion and Cradoc coals. While this suggests that Mersey coal is of Greta age and that Mole Creek, Mount Pelion, and Cradoc occurrences are of Upper Coal Measure age, it is contradicted by the fact that P3B and P13A (confined to Upper Coal Measures in New South Wales) occur in the Mersey and Wynyard coals but not in the Mount Pelion and Cradoc samples. Furthermore, P9A (absent from New South Wales Greta) was found in two of the Mersey coals and the Cradoc sample.

It follows that no conclusions can be reached at this stage by studying the presence and absence of types which appear to have restricted ranges. This is not surprising in view of the distance between Tasmania and New South Wales and the palaeogeographical variations in environment which probably existed between the two areas during Permian time. Conditions favouring certain plants in New South Wales during Greta or Upper Coal Measure deposition may not have existed during deposition of equivalent strata in Tasmania, some 700 miles away.

SUMMARY.

Permian coal samples were examined from nine localities in Tasmania and microspores were found in all except one from Preolea. Of the forty-eight spore-types described from New South Wales Permian coals, forty-three were found in Tasmania. Four new types, not recognized in New South Wales, were observed in Tasmanian coals. Monowinged spores are almost completely absent in Tasmanian coals, although they are present in the Permian of New South Wales, Victoria, Western Australia and India. Biwinged spores are far less common in Tasmania than in New South Wales. Coals from Wynyard and the Mersey field (Illamatha, Aberdeen, and Tarleton) are characterized by the absence of echinate spores which are relatively abundant in Cradoc, Mount Pelion and Mole Creek coals. Evidence based on assemblages supports existing views that Mersey and Wynyard coals are equivalent and occur on a different horizon from Mount Pelion and Cradoc coals. The assemblage in Mole Creek coal resembles that of Mount Pelion and Cradoc materials rather than the Mersey coals, with which it was previously believed to be equivalent. The study of presence and absence of types with limited ranges in New South Wales produced conflicting results when

applied to correlation of Tasmanian occurrences with subdivision of New South Wales Permian.

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